

# Green PowerNL HCA Roadmap North Region.

Arjen van der Meer, Jan-jaap Aué, Marcel Koenis, Harm van Lieshout,  
Jeroen Rijnhart, Marieke Abbink, Willem Hazenberg, Roeland Hogt  
Feb. 27, 2024

# 1 Management summary<sup>1</sup>

**As Europe's first Hydrogen Valley, the Northern Netherlands has made great strides in recent years toward the rollout of a hydrogen ecosystem. To accelerate chain development, closer cooperation is needed, facilities must be further integrated, and employers, employees, knowledge and educational institutions must work together on innovative ways to develop competencies. This roadmap provides insight into the steps the Northern Netherlands will take together with GroenvermogenNL toward a responsive labor market for green hydrogen.**

## 1.1 Hydrogen Valley Northern Netherlands

The Northern Netherlands is in the midst of greening fossil-driven activity through hydrogen applications, among other things. As Hydrogen Valley, our region has already taken important steps toward the implementation of the €9 billion regional investment agenda and the establishment of the hydrogen economy. Technology development, application in the market and the demand for the right knowledge and skills and training are closely intertwined in this process. From different perspectives such as employees, employers, governments and knowledge institutions, there is a need for policy instruments, legal frameworks and development capacity to align investment plans and further close the value chains.

A responsive learning, working, and innovation culture is needed to accelerate and scale up the redesign of a total of 66 thousand jobs. This roadmap outlines ambitions for the joint design of this infrastructure building on current and upcoming initiatives. Of essential importance is a regionally coherent approach that is set up in a future-proof manner. This allows training, testing and innovation instruments to be aligned with each other, with the needs of the labor market and with policy and funding programs (regionally and nationally) so that maximum synergy is achieved in goals and activities.

Scaling up hydrogen applications requires not only cooperation but also a culture in which the (open) sharing of knowledge about working with hydrogen prevails. Further development of technology, scaling up the application, strengthening learning communities and accelerating knowledge exchange (e.g. via a digital knowledge platform) go hand in hand with the flexible design of training to meet the needs of employers and contractors.

The energy transition stands or falls with the timely elimination of and creative handling of shortages and scarcities in various areas: physical infrastructure (congestion), sustainable electricity generation (wind, PV) and the public space and labor force required for that purpose. The latter mainly involves practically educated professionals and that shortage will have to be broadly addressed; there is a great need for change in approaching training programs for MBOs. The change that has been going on for decades in HBO (professors, practice-based research, learning communities) will have to be accelerated in MBO.

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<sup>1</sup> Available as an integral brochure at <https://groenvermogennl.org>

With these tools, the Northern Netherlands, together with GroenvermogenNL, wants to lead the way for a responsive labor market for green hydrogen as a blueprint for the entire energy sector.

## 1.2 Regional Outline

The use of emission-free hydrogen is crucial to making energy and raw material supplies more sustainable. Commissioned by regional companies and governments, an investment plan with a size of over EUR 9 billion has been drawn up. Central to this is the (further) development of a hydrogen ecosystem, also taking into account the sectoral transitions to green jobs and the further development of knowledge in the field of hydrogen. The plan foresees a part to initiate activities in the hydrogen chain (up-, mid-, downstream) (up to 2025, up to 100 MW) and part to close and scale up the chains (2030, GW-scale installations). This laid the foundation for the further expansion of the hydrogen valley Northern Netherlands with HEAVENN, Waterstofnetwerk Nederland and North2 as leading programs. Since then, the expected portfolio has continued to expand, both in scale and estimated investment size. Further programming around hydrogen is ongoing through, among others, Baanbrekers within NPG (National Program Groningen), in which the hydrogen economy and circular economy are important pillars, Nij Begun, in which green hydrogen becomes an integral part within the economic agenda for sustainable growth, and Hydrogen Valley Campus Europe (HVCE), in which knowledge (valorization), education and innovation are further integrated.

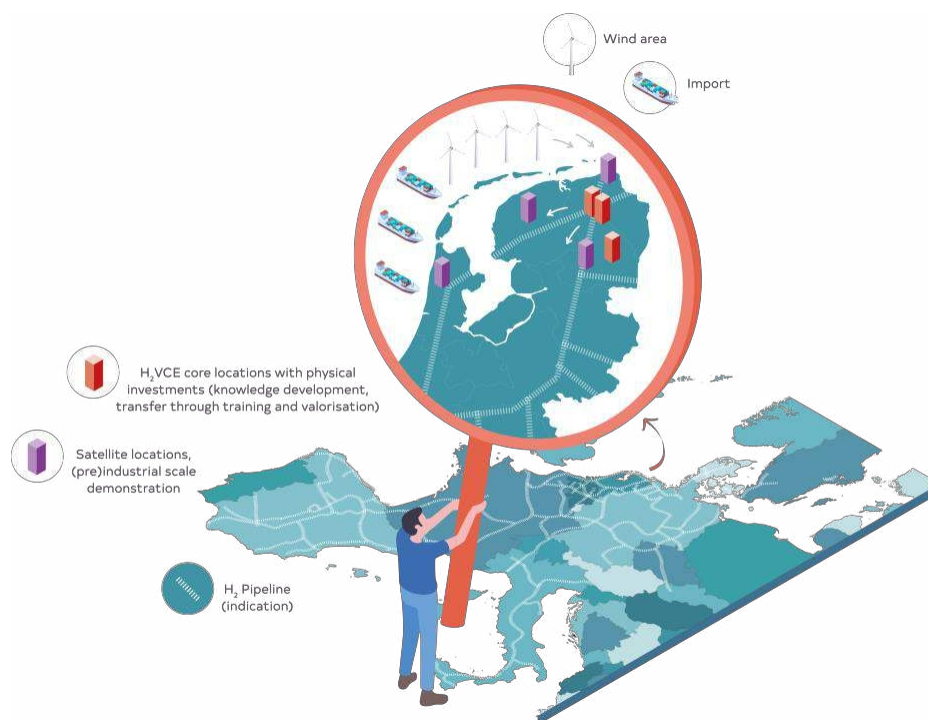


Figure 1 Positioning and core locations Hydrogen Valley Campus Europe

## 1.3 Ambitions and intended activities

Integration and stimulation of the knowledge ecosystem of regional campuses and training centers takes place within HVCE. Under this umbrella, Waterstof Werkt (2000 trained hydrogen professionals in 2027, further development of existing course offerings within MBO/HBO/WO into continuous learning lines for hydrogen) will be implemented and further integration of experimental and training facilities will take place with development of digital tooling for better accessibility and a flexible training offer.

### Further ahead, it is important that

- retraining is facilitated as much as possible. A flexible and stackable Lifelong Development (LLO) offer is crucial in this regard.
- Activity, education, knowledge development and policy-making become more closely intertwined, in height (investment and development climate), breadth (innovation and start-ups), and depth (attractive region with an impact on other sectors)
- The MBO will have a more central position in the programming and implementation of the HCA
- Structurally facilitate regional SMEs, such as with the Green Hydrogen Booster, in the greening of their process, including with hydrogen, including through knowledge sharing

In doing so, we are jumping on a moving train with GroenvermogenNL. Some programs are already heading for funding, some are in the concept phase or fall between the cracks in terms of funding. GroenvermogenNL steps in where there is a demand for a facilitating role in HCA development, a connection needs to be made with national initiatives, and training and knowledge needs to be developed. A number of concrete activities and results have been defined that require a cumulative financial impulse of EUR 9 million.

### 6 Pillars for a responsive green hydrogen labor market in the Northern Netherlands

1. Ongoing regionally cohesive approach
2. Valorization National Hydrogen Knowledge Platform
3. Improved Positioning MBO in HCA green hydrogen
4. Scaling up learning communities Hydrogen
5. LLO & new (integrated, time- and location-independent, digital, multimedia) ways of working, learning, innovating
6. Research and Development (linkage with Human Capital agenda-setting)

## 1.4 Key stakeholders

**Green hydrogen developments are intersectorally and administratively broadly supported in the region, with key stakeholders in ongoing and estimated initiatives:**

- Regional partnerships: [New Energy Coalition](#), [HyNorth](#), [Groningen Seaports](#), [Industry Table North Netherlands](#), [Cooperation North Netherlands](#), [Hydrogen Valley Campus Europe](#), [Chemport Europe](#)
- Industry associations: [Techniek Nederland](#), [NetbeheerNL](#), [EBN](#), [Wij Techniek](#), [Bouwend Nederland](#)
- Knowledge Institutions: [University of Groningen](#), [University of the North](#), [Watercampus Leeuwarden](#), [ENTRANCE](#), [TNO](#)
- Training: [Noorderpoort College](#), [Drenthe College](#), [Alfa-College](#), [Firda](#), [Centre of Expertise Water Technology](#), [Hanze University Groningen](#), [HanzePro](#), [New Energy Business School](#)
- Companies and institutions: [Gasunie](#), [Nobian](#), [Resato Hydrogen](#), [Holthausen Clean Technology](#), [DNV](#), [Stork](#), [RWE](#), [Engie](#), [Shell](#), [NAM](#), [Afeer](#),
- Governments: Provinces [Fryslan](#), [Groningen](#), [Drenthe](#); several municipalities, learning communities, water boards
- Networking: business parks Groningen, [Hydrogreenn](#),

who are directly or indirectly involved in GVNL's regional liaison team in the Northern Netherlands. The liaison team holds ongoing discussions and joins (regional) meetings and initiatives on labor market issues and developments around (green) hydrogen.

## 1.5 Coherence

In addition to successful cooperation clusters in the energy/industry/water nexus (e.g. Seaports, [Chemiepark Delfzijl](#), [Greenwise campus](#), [WaterCampus](#) Leeuwarden), the Northern Netherlands has strong (public-private) partnerships for developing the hydrogen economy, anchored in Europe's first Hydrogen Valley and shaping the implementation of the investment agenda. HVCE is the programming of the knowledge ecosystem around hydrogen, within which various hubs respond to learning, innovation and valorization needs through funding instruments at European (Horizon, Interreg, JTF), national (GroenvermogenNL, LLO- Katalysator, Katapult, MMIPs) and regional (NPG, Baanbrekers, Nij Begun) levels. The approach of GroenvermogenNL lends itself well to strengthening regionally coherent approaches, facilitating the rollout to closure of local hydrogen chains at the national level.

GroenvermogenNL fits this perfectly: the 6 pillars with which the Northern Netherlands intends to build knowledge, education, and cooperation impulses within GroenvermogenNL strengthens cooperation and accelerates the rollout of activities within existing programming of the knowledge and investment ecosystem.

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# 3 Introduction

The present document is the result of the regional exploration in the field of human capital development in the Northern Netherlands, as carried out within the HCA pillar of GroenvermogenNL (GVNL) a program within the framework of the National Growth Funds. This regional roadmap provides insight into the labor market issues, the initiatives in the field of developing a (green) hydrogen economy and the interrelationship with connecting regionally planned developments. From that playing field, we look at programs under development as well as in the implementation phase. Much is already underway but some necessary activities still fall between the cracks. With GVNL, Northern Netherlands wants to be effective in the region in those areas as well. Results that are needed for impact on an (inter)national scale and the realization of a fully-fledged green hydrogen economy will accelerate. It must be said that in the case of (green) hydrogen applications, the technology (access to market level) and legal frameworks are not yet fully developed while the social need to implement is great. This also leads to a chicken-and-egg challenge in terms of competency development: when should we train whom and in what? A responsive infrastructure (of organizations, people and facilities) is needed and this roadmap provides the tools to realize that as a region.

## A Liaison Team consisting of:

- *Jan-jaap Aué*, director ENTRANCE and lector hydrogen applications Hanzehogeschool
- *Marcel Koenis*, director of business development ENTRANCE
- *Marieke Abbink*, CEO New Energy Coalition
- *Jeroen Rijnhart*, general director Center of Expertise Water Technology (CEW-Water Campus)
- *Harm van Lieshout*, lecturer in human capital Hanzehogeschool
- *Willem Hazenberg*, practor hydrogen in industry and networks, Drenthe College and Senior Consultant Stork Asset Management Technology
- *Roeland Hogt*, practor automotive, coordinator hydrogen education Noorderpoort
- *Arjen van der Meer*, research coordinator and project leader ENTRANCE

With this, the field and knowledge institutions are well represented both geographically (Friesland, Groningen, Drenthe) and across sectors (mobility, industry, T&D and applications) in the region. In addition, the team is strongly anchored in relevant regional networks such as Industry Table North, Hydrogen Works, HYDROGREENN (HYDROGen Green Regional Energy Economy Network Northern Netherlands) and HVCE (Hydrogen Valley Campus Europe), allowing for demand articulation from multiple perspectives and disciplines, which contributes to the support of the roadmap and provides the right managerial strength. In recent years, in human capital projects in the Northern Netherlands we have deliberately worked with an integral team. This team knows each other and the relevant institutions well, which promotes a coherent approach.



The roadmap is structured as follows. In section 4 we begin with a comprehensive environmental exploration of the labor market and human capital projects that have an initiating effect on sectors and chains. This provides a regional picture of current efforts around green hydrogen. Then, in section 5, we will explore how we can move from the current situation to a responsive infrastructure for green hydrogen over the next decade. Ongoing policy instruments, planned activities and innovation are central to this. Within this range of initiatives, GroenvermogenNL can make a difference within the region, which will also find its knock-on effect at the national level. In section 6, this leads to six pillars with which the region wants to work. Then, in sections 7 and 8 respectively, we look at the further refinement into partial results and activities, governance and coherence. Cumulatively, the activities require a financial boost of EUR 9 million on top of existing ongoing regional HCA initiatives in the field of green hydrogen.

## 4 Environmental Outlook

The Northern Netherlands already has ample experience in initiating and rolling out hydrogen infrastructure, applications and education. We begin with an overview of the hydrogen ecosystem. Then we zoom in on the regional labor market situation and the action perspective from employees, employers, knowledge institutions and governments.

This is followed by an inventory of current and completed projects and activities that have been initiated within the Northern Netherlands. Initiating means: having a driving effect on (parts of) the hydrogen chain.

### 4.1 Northern Netherlands: the first European Hydrogen Valley

In recent decades, the Northern Netherlands has developed value chains around industrial clusters in which fossil resources, especially natural gas, are used as raw material. It is estimated that the size of the regional labor market (direct and indirect) in this fossil sector is 66 thousand professionals. In the wake of the closing of the Groningen natural gas fields and the greening of industry, regional governments, industry, knowledge and educational institutions have developed programs around the production, transport and storage and application of hydrogen as an energy carrier and as a raw material. This public-private partnership (New Energy Coalition and Samenwerkingsverband Noord-Nederland) led to European recognition in 2019 as the first

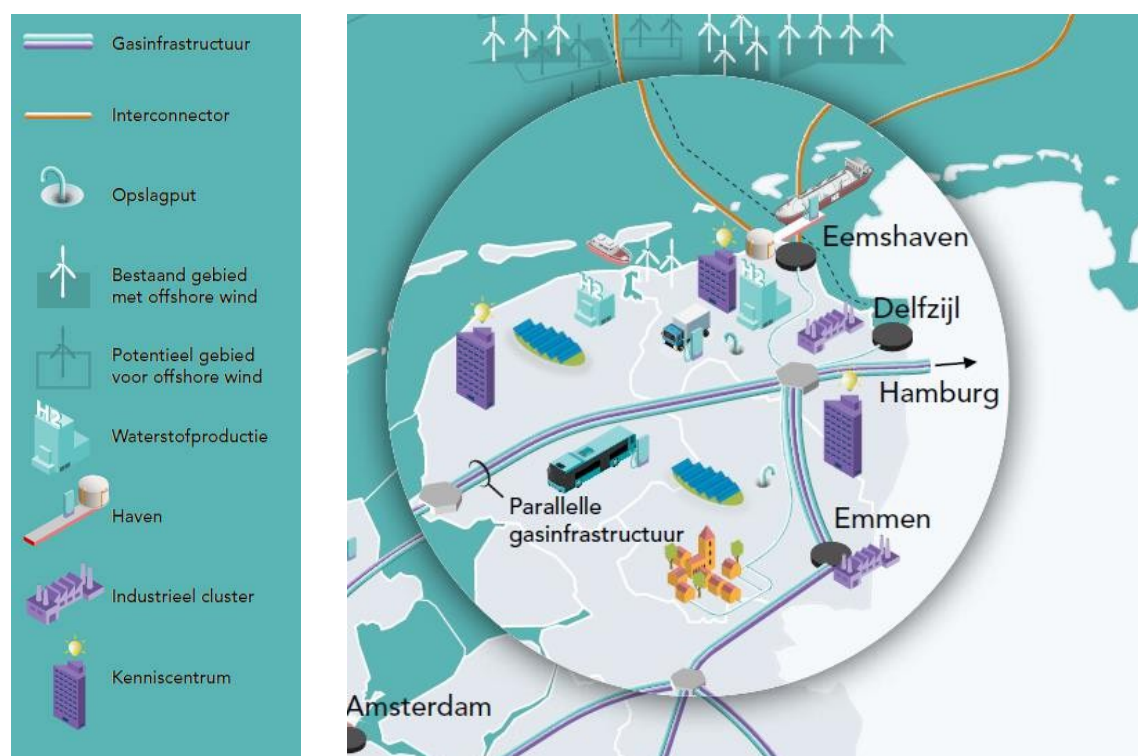


Figure 2- Planned regional hydrogen ecosystem toward 2030. Source: investment plan North Netherlands 2020

hydrogen valley of Europe<sup>2</sup>, with HEAVENN as the main project to develop and scale up value chains<sup>3</sup>. In parallel, governments and industry worked on the Integral Hydrogen Plan for the Northern Netherlands<sup>4</sup> and the 2020 Hydrogen Investment Plan for the Northern Netherlands to further expand and (inter)nationally replicate the hydrogen valley<sup>5</sup>. With an investment package of EUR 9 billion, the investment plan embraces the

- Production of 100 PJ of hydrogen per year by 2030, of which more than 70% will be green;
- Establishing a hydrogen transportation and distribution system;
- Large-scale hydrogen storage (0.75PJ first phase);
- Encouraging manufacturing around hydrogen;
- Initiating and scaling up hydrogen applications.

The portfolio has since expanded further, including new sectors and stakeholders. The roadmap is flanked by a regional implementation plan to realize the investments in the short and medium term. One of the implementation areas is embedding the investments in the larger hydrogen ecosystem, which also focuses on employment, competence development through re/training on top of maintaining existing jobs 25 to 41 thousand new jobs in the sector. Meanwhile, there are formative, regionally funded programs in this area such as Hydrogen Works, where the main goal is to train 2,000 hydrogen professionals<sup>6</sup>. Central to this is closer cooperation between MBO/HBO/WO, among other things, by coordinating continuous learning lines. Furthermore, technology and regulations surrounding hydrogen are in continuous development, with innovation, learning and working closely intertwined.

The Northern Netherlands ranks among the European leaders in fundamental hydrogen research and development through experimentation centers. *Learning* communities (LCs) are a proven vehicle for developing multidisciplinary technical innovations, adapting the supply of training, and incorporating hydrogen into existing and new business models. Further integration of activities and programming for knowledge, innovation and pervasiveness is taking place under the umbrella of Hydrogen Valley Campus Europe (HVCE)<sup>7</sup>

## 4.2 Regional labor market situation and prospects for action

A human capital agenda often begins with the demand for suitable supply of **workers** and thus the learning and working of the individual. In doing so, one then often focuses first on desired inflows of young people from initial vocational and higher education. The education system is structured according to the idea that every young citizen, after a free choice of education and career, enters the labor market through a chosen and preferably graduate vocational or higher education, preferably in a position in a company/organization appropriate to that position. Companies are thus dependent on that free educational and career choice. The technical sector has long suffered from a lower than desirable intake (although the outflow of technicians in training and on the labor market is an equally important factor for the shortage) and has long been investing in projects such as

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<sup>2</sup> By Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU); transferred to European Partnership for Hydrogen Technologies in 2021, <https://www.clean-hydrogen.europa.eu/>

<sup>3</sup> H<sub>2</sub> Energy Applications in Valley Environments for Northern Netherlands, <https://heavenn.org/>

<sup>4</sup> Available online at <https://www.provinciegroningen.nl/>

<sup>5</sup> Online: <https://www.newenergycoalition.org/nederland-waterstofland-investeringsplan-van-9-miljard-euro-moet-leiden-tot-leading-position-in-europe/>

<sup>6</sup> <https://www.newenergycoalition.org/waterstof-werkt/>, turned into JTF H2 Train and Learn Hub in September 2023

<sup>7</sup> <https://www.rug.nl/wubbo-ockels-school/research/hydrogen-centre/collaboration/>

TechYourFuture<sup>8</sup> to boost that influx. Recently, the influx into engineering has been relatively slightly more positive. We see in our region that, thanks to a vanguard function in energy transition and appropriate educational facilities and innovations to go with it, we are already attracting energy transition-motivated talent even from several other countries from around the world.

But as the Green PowerNL labor market survey<sup>9</sup> observes: in times of de-greening, aging and labor market shortages, the energy transition requires much more than intake from initial education. Training of workers at energy-related companies where the work and thus the functions are changing, and especially lateral inflow from other sectors, are also much needed. First

### Perspectief werknemer



Figure SEQ Figure ARABIC 3 Employee action perspective overview

educational and vocational choices are already difficult for young people (there is a reluctance to act), and the first choice is often changed again. Later in life, however, there is greater reluctance to change careers: people need their current job (or benefits) to support themselves, and they are often at the peak of their lives with child-rearing and family care responsibilities. To actually make a transition to another profession/sector or business, a concrete perspective of a new and (preferably better) job is more than desirable.

In theory, training of incumbent employees at companies that are (partly) already active in hydrogen is the least of the problems: work-based learning and corporate training investment should sooner or later ensure that they develop their competences in the desired direction—then the pace at which companies are active in (green) hydrogen is very important, as we will elaborate later. But a growth sector like the hydrogen ecosystem also needs (at least temporarily) a large-scale influx of new employees at existing and/or new companies. So here we are at this stage for a sector that needs to grow as fast as possible with a multiple challenge:

Unfortunately, there is no external reserve of hydrogen talent. Many technical positions where the job market was already tight are becoming even tighter in terms of inflow of young people. Only a small portion of the upcoming generation will invest in hydrogen training without a concrete job offer. For lateral entrants, a short-term job prospect is almost a necessary prerequisite: (new) opportunity precedes motivation to (co)invest in hydrogen competency development.

<sup>8</sup> <https://www.techyourfuture.nl/>

<sup>9</sup> A. Bachaus *et al.*, Labor Market Research Hydrogen Transition, CE Delft/SEO Economic Research, Nov 2023, Available online at : <https://groenvermogen.nl/documents/>

Many concrete jobs for the (green) hydrogen sector are in the future: numerous regional hydrogen projects are in preparation, involving hundreds of people. However, an FID (Final Investment Decision) has not yet been taken due to various market uncertainties, Uncertainty is inseparable from this phase, but the lack of an adequate legal framework and the necessary government instruments to develop a solid business case complicates market maturity. Moreover, the November 2023 elections have further delayed developments.

For companies, investing in lateral entry is cheaper the better match the competencies of lateral entry workers, but unfortunately, technicians are scarce and can be employed in many places. Existing, fossil energy-based companies that go along with (green) hydrogen can themselves contribute to retraining and upskilling their staff and new influx, but thus find themselves in a shrinking market with their "old" activities.

In any case, the total influx is not yet enough. In the North region, the labor market region is organizing a Talent Tour with festivals in different places in the coming years to inform citizens. And they want to expand the physical Talent Platform in Groningen City to more locations in Ommeland<sup>10</sup>. From ongoing and new projects, we want to contribute content and contact in this regard from GroenvermogenNL.

This brings us immediately to the next and perhaps most important actor: **labor organizations/employers**. As just discussed, the main reason for career/training choices of citizens in their direction is the job and income security that employers (young and older) can offer talent. Desired inflow refers, on the one hand, to quantitatively sufficient graduates with exactly the right qualifications: the ideal prior education for their profession and the various positions within it: the right competencies in the right degree of mastery. Employers also define the actual demand for labor - they define jobs and their associated tasks, thus determining the competencies required of workers. They can and should provide their incumbent workforce schools as their product or production process changes, and thus tasks and functions change. So they themselves are also the first and most effective means of translating changed demand into improved competencies - through work-based learning of their incumbents, of their trainees and graduates, of the school-based training that those trainees and graduate students get, and preferably from training with their chain partners.

### Perspectief werkgever



<sup>10</sup> <https://talentperron.nl/>

HCA formation sometimes narrows the perspective too much to what for companies is the back end of their strategy and operations: recruiting (and training) qualified personnel. Especially in a sector with significant technical innovations, such as hydrogen, new innovation, the search for (otherwise) qualified personnel follows from (changed) business cases, financing, adaptation of work processes, and adaptation of the organization of work and job building. A host of other business choices must be made and realized before (more) demand for hydrogen-skilled talent arises. Hydrogen requires product /and or process innovation in a company before hydrogen employment grows and demand for (specialized) talent arises.

**The logical sequence of business choices is:**

- New business plan (create new hydrogen product, or innovate hydrogen in our process)
- Funding/investment
- Changing work organization (new/changing functions)
- (and only then) self-training and/or new recruiting to properly staff changing job structures

This makes a Human Capital agenda focus not only on the competency development of (future) employees, but precisely also on the business and competency development of entrepreneurs, business leaders and their companies. Every company that switches to hydrogen earlier/more quickly accelerates the energy transition, creates a need and strengthens the human capital agenda, competence development through informal learning on the job and (new) education and training. This also requires different competencies for teachers. This will also require them to be retrained.

Thus, in the context of human capital-agenda formation, we want to offer business service measures not only at the "back end," but through the broader range of choices that precede (changed) talent demand: from kitchen-table discussions with entrepreneurs/managers who are beginning to explore what green hydrogen means to them, through assistance with business case development and assistance with labor-organizational development, to assistance in developing the right training offer - in the company and in education. Sometimes this can be done by offering a course/learning, sometimes other interventions are needed. From the Center of Expertise Entrepreneurship of the Hanzehogeschool, for example, a methodology for assistance in strategic personnel planning for companies has already been developed under the *Sector Plan Groningen op Voorsprong*, and with the Green Hydrogen Booster<sup>11</sup>, EnTranCe offers assistance with technological innovations. In the coming years, we want to offer a comprehensive menu for help with key business choices. What is even more relevant here is that companies make their (change of) business case not in isolation, but in a chain of interdependence: if my customers are not yet ready for hydrogen, my new hydrogen business case is particularly risky, and if my suppliers cannot yet deliver the technology needed for my business case at the right TRL, equally so. Financing and insurance then becomes problematic. There are also laws and regulations that still too often hinder and inhibit innovation acceleration and implementation. Permit issuers also have a strong need to better understand the required regulations or equivalence principle around hydrogen (besides future employees and entrepreneurs/company managers, administrators/lawyers/supervisors are also a relevant target group for a human capital agenda). Thus, also at companies, for several reasons, there is (understandable)

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<sup>11</sup> Voucher scheme for launching hydrogen applications for SMEs in the Northern Netherlands, completed October 2023 (<https://www.groenewaterstofbooster.nl/>)

acting embarrassment that inhibits (human capital) investment in hydrogen applications. And because Groningen and the Northern Netherlands (apart from a small number of large companies that have their origins in "old" energy) is predominantly branch-industry an SME economy, organizing and facilitating togetherness in many areas (business case development, financing/investment, and employment) is an important - seemingly necessary - tool.

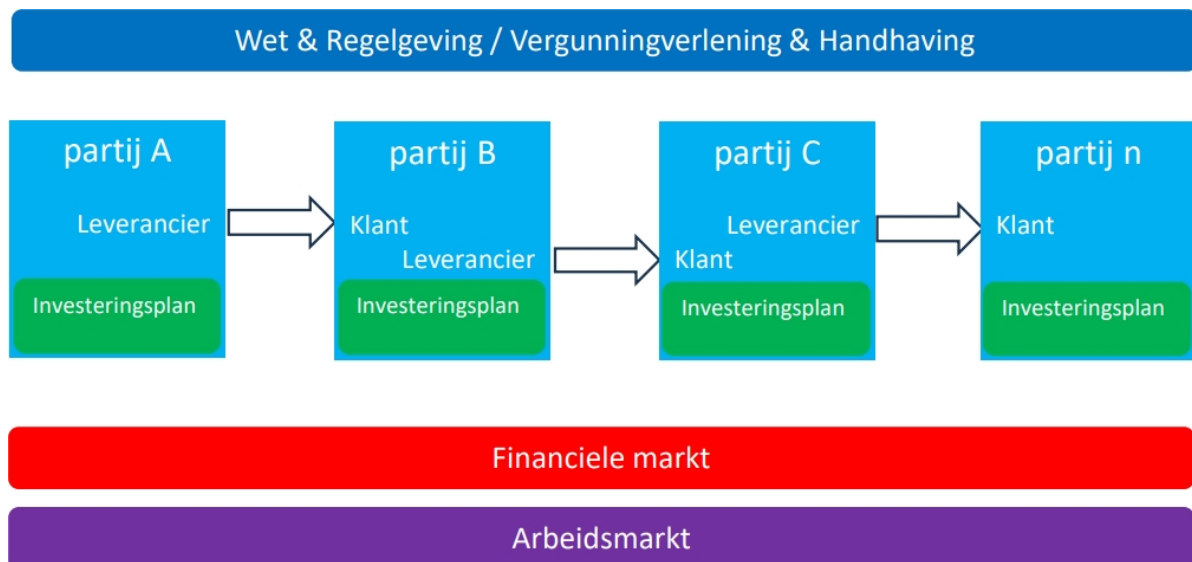


Figure SEQ Figure ARABIC 5 Illustration chain dependence for new technological developments such as the hydrogen economy.

**Such an investment plan (the small green block next to each company in Figure 5) then involves**

- Change of activities
- Change of work processes
- Change of skills
- Investment in equipment
- Investment in organization
- Investment in people

For hydrogen, for example, (core of) the chain is presented like this:

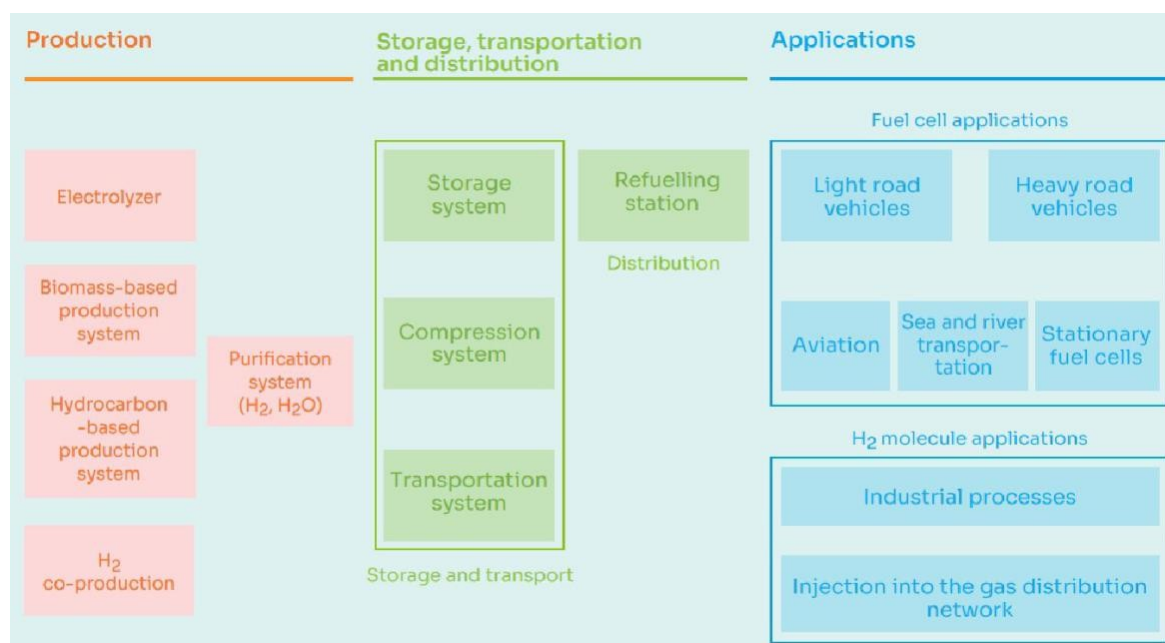


Figure 6 Chain view of the hydrogen ecosystem (energy carrier & feedstock).<sup>12</sup>

Needs of individual companies differ depending on their position in the chain. On the basis of a number of segments (hydrogen production; storage, transport and distribution, the manufacturing industry, hydrogen trading, maintenance and engineering, permit providers and financial institutions), we distinguish the following example situations in the region:

**Djewels**<sup>13</sup> is a pioneering project to demonstrate the feasibility of *hydrogen production* for renewable fuel on an industrial scale. HyCC will develop the first 20-megawatt water electrolysis facility to produce 3,000 tons of green hydrogen per year. In addition to HyCC, Nobian and other parties are involved. Construction will start in 2024. Here staff planning (on quality and quantity) can be supported and monitored, both for the development phase and then for permanent operation. An already identified bottleneck concerns *safety engineers*.

**HyStock**<sup>14</sup> is developing salt caverns near Veendam for *hydrogen storage*. Parties involved are Gasunie, EnergyStock and Nobian. Construction has started and it currently involves about 25 FTE in mostly legal, commercial and technical jobs. The first cavern is scheduled to become operational in 2028. The other three caverns will be shortly after 2030, in line with the growth of the renewable hydrogen market. So here, too, personnel planning (on quality and quantity) can be supported and monitored from first the development phase to later permanent operation. Already identified bottlenecks are (also) safety engineers, need for *engineers in general*, and *hydrogen training* in the company.

<sup>12</sup> Source: W.D. Hazenberg, Competencies Needed For Hydrogen In The Industry And Network For Vocational Education (MBO), Apr 2023

<sup>13</sup> <https://djewels.eu/>

<sup>14</sup> <https://www.hystock.nl/>



Gasunie's national natural gas network can be used in part to create a **national hydrogen network**<sup>15</sup>. The HyWay27<sup>16</sup> study aimed to show that this is technically possible and socially desirable. A hydrogen network contributes to the climate goals and realizes an international market for climate-neutral molecules. The Ministry of Economic Affairs asked Gasunie to start developing this *hydrogen network*. Construction has begun; in addition to Gasunie, other parties are involved. So here too, staff planning (on quality and quantity) can be supported and monitored from first the development phase; and here too, safety engineers are an important already identified bottleneck.

In the *manufacturing industry*, we have several other frontrunners in hydrogen, such as **Holthausen** and **Resato**, besides **Hyzon** (where staff forecasts have recently been revised downward because of a modified business case). These are almost always (M)KB companies that are still developing their product for a market that has yet to develop, and where the companies are growing rapidly anyway. That's a particularly challenging split. Such promising new (frontrunner) companies in (green) hydrogen have (need) a rate of growth that they find difficult to achieve on their own. A company that wants to go from 100 jobs to 1,000 in 10 years would need a training ratio of 1 trainee/seeker per year per employee. We normally work with a training ratio of one trainee for every 10 employees.

*Maintenance and engineering companies*, such as Billfinger Tebodin and Stork, specialize in the design, construction and maintenance of industrial plants. Much remains to be researched in the field of failure behavior and maintenance. This knowledge is crucial for future asset management and must be converted into effective inspection and maintenance plans.

*Licensing, enforcement and environmental safety agencies* play a crucial role in issuing permits and assessing and managing environmental risks. In the event of emergencies, they are responsible for enforcement and intervention. Examples of such agencies include the Province of Groningen/Drenthe, the Environmental Safety Region of Groningen/Drenthe and various municipal departments.

*Financiers and insurers* of projects, such as the facilities or buildings/locations where they are located, play a crucial role. Examples include Rabobank and Univé. They are responsible for making a realistic risk assessment  
So such companies need help organizing that qualitative and quantitative growth.

Cooperation between water-related companies in employment (in training, induction and deployment of personnel, and possibly even joint employment or an employment pool) can help. Besides cooperation, (public) help is desirable, which can take different forms: joint training facilities (of which we have already realized a number in this way in the region) to further develop off-the-job retraining; help with product development as we have developed in the Green Hydrogen Booster; train-the-trainer (or better the workplace trainer) offer; actual guidance from education in companies and the already mentioned help with personnel planning; and possibly thus helping to realize a

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<sup>15</sup> <https://www.gasunie.nl/projecten/waterstofnetwerk-nederland>

<sup>16</sup> Detz, R. Weeda, M., van Stralen, J., Hydrogen in the Netherlands--A review of recent Dutch scenario studies, TNO report, Jul 2020, online: <https://www.hyway27.nl/gelieerde-rapporten-en-beleidsbrieven>

joint training activity (GOA) that can also take on employer responsibility for new (side) intake at the intake stage.

Last but not least, of course, there is the group of companies that do not yet know if or how and when to (continue to) develop hydrogen jobs in their functional building. (By definition, this phase contains the vast majority of companies in a region). Given the aforementioned chain dependency in investments that can be inhibitory, we are already paying permanent attention to this group in our plans as well, to welcome them as customer/supplier chain partners earlier through timely information. If more business parks decide earlier that they want to do something with hydrogen and have a connection to that developing national hydrogen network, the expectation is that the network will develop all the faster, with a strengthening and accelerating effect on the hydrogen market as a whole. Indeed, informing this group of companies also helps to alert their incumbent employees to a possible career future in the green hydrogen economy.

### **Educational and knowledge institutions**

are, of course, the third group of relevant actors. Desired inflow refers, on the one hand, to quantitatively sufficient graduates and teachers with exactly the right qualifications: the ideal preliminary training for their profession and the different function within it: the right competencies in the right degree of mastery. Quantitatively, educational institutions have limited possibilities to influence the influx of freely choosing young people. Qualitatively, however, they are an important actor: they can help to translate knowledge from forerunner companies into descriptions of changing/new jobs and competencies, and therefrom learning objectives, curricula and forms of education for developing and providing - for basically all forms of school and work-based learning as forms of lifelong development - starting in initial education and building on this until after retirement age.

#### **Human Capital Agenda North Netherlands**<sup>17</sup>

The generic Human Capital Agenda for the Northern Netherlands contains the following ambition: A well-functioning labor market that is ready for the transitions and within which Every resident can participate in the labor market and continuously develop (learning culture);  
Every SME can recruit, retain and develop staff;  
The learning culture is optimally developed;  
Education and labor market are closely linked;  
Governments cooperate and support each other  
In a consortium of the three Northern Provinces, three Northern labor market regions (municipalities and UWV) and the North Netherlands Cooperation Agency (SNN)

<sup>17</sup> SER Northern Netherlands, Human Capital Agenda Northern Netherlands, June 2014, online: [https://www.sernoordnederland.nl/assets/Adviezen/105\\_14HCA/human-capital-agenda.pdf](https://www.sernoordnederland.nl/assets/Adviezen/105_14HCA/human-capital-agenda.pdf)

**There is already a rich palette of interventions in our region on which we will build in the coming years, such as:**

- University of the North, an umbrella collaboration of regional WO and HBO and MBO with the flagship project GreenWise Campus in Emmen with a continuous learning line.<sup>18</sup>
- Northern MBO consultation, MBO-HBO consultation<sup>19</sup>
- North learns by<sup>20</sup>
- Green hydrogen booster (GWB).
- Hydrogen works
- Green transition in water, chemistry and food
- ENTRANCE
- New Energy Coalition
- LLO North Netherlands action plan
- Gas 2.0<sup>21</sup>
- Learning community system integration
- GreenWise Campus Emmen
- Water Campus Leeuwarden
- Hydrogen Valley Campus Europe (HVCE).
- Wadden Campus

of which we will dwell on some of the initiating activities in a little more detail later in this roadmap.

The Northern knowledge institutions have the ambition to work together on a vital, prosperous and attractive Northern Netherlands, in which the international competitive position is strengthened in a number of spearheads (RIS3<sup>22</sup>), the economic basis is anchored in a vital regional economy, where the essential environmental conditions are distinctive and we cooperate on the basis of integral principles. The knowledge institutions have established two important administrative bodies to realize cooperation on the regional themes. The Northern wo- and the hbo- institutions have together established an outline knowledge agenda in the partnership University of the North. The MBO works closely together in the Northern MBO consultation and with the hbo in the MBO-HBO consultation. Through this, MBO is also connected to the knowledge agenda and the University of the North, and formally joined it this summer. In the Northern Netherlands, the knowledge institutions have been regularly working together on LLO solutions for some time by developing joint knowledge offerings. A good example is the horizontal cooperation of the northern MBOs within "Het Noorden Leert Door. An example of vertical cooperation is the courses in Circular Economy and Computer Vision between MBO Drenthe College and HBO NHL Stenden.

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<sup>18</sup> <https://universiteitvanhetnoorden.nl/>

<sup>19</sup> <https://www.mbohbonoordnederland.nl/>

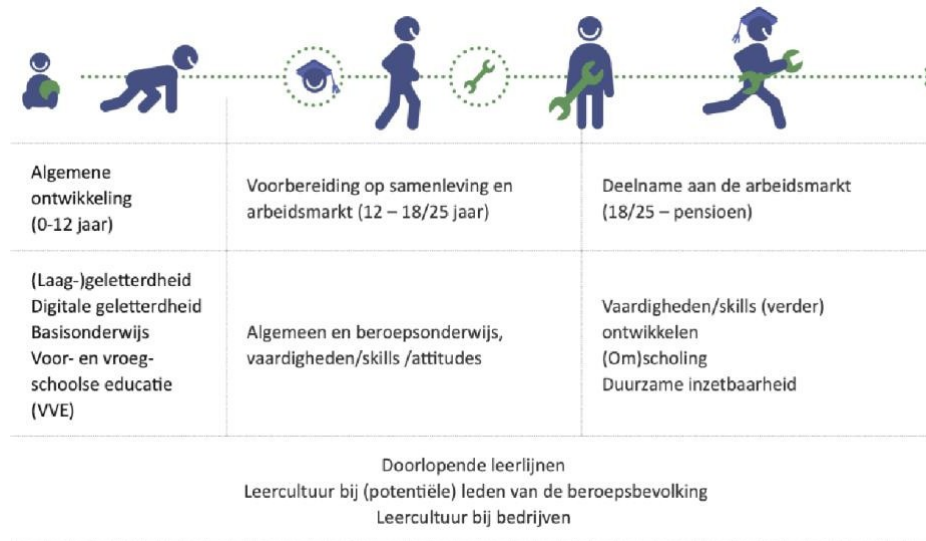
<sup>20</sup> <https://www.hetnoordenleertdoor.nl/>

<sup>21</sup> <https://energycollege.org/>

<sup>22</sup> <https://www.snn.nl/programmas/ris3-strategie-voor-het-noorden>

**Working for Development in the Province of Groningen 2021 - 2024**

In March 2021, administrators from municipalities in the Labor Market Region of Groningen, the province, the knowledge institutions of MBO and HBO, and regional Employer and employee organizations signed the program proposal *Working on Development*.<sup>23</sup>



This program outlines the program lines for investment in the regional labor market and serves as the framework for the Learning and Working theme within the NPG. The following five challenges are outlined in this unique partnership. A transition from a (predominantly) initial education system to lifelong development 2. A stronger connection between learning and working 3. Reliable information on targeted development 4. Strengthening cooperation between all parties in the labor market 5. Strengthening the culture of learning.

Another example is the collaboration between Noorderpoort, Hanzehogeschool and RUG on energy education for wind energy (Offshore Wind Innovation Centre) and hydrogen (Green Hydrogen Booster). With ENTRANCE and New Energy Coalition in the Northern Netherlands and the further development of the University of the North, horizontal and vertical cooperation in energy transition will increase even more. In the Northern Administrative MBO-HBO consultation, in consultation with the University of Groningen (RUG), a joint Action Plan for Lifelong Development in the Northern Netherlands (APLLONN) has been developed for the period 2023-2030. With this plan, the Northern educational and knowledge institutions will play an active role in the further development of citizens, working together on regional transition tasks, as well as supporting companies in organizing a stimulating learning culture and conducting research relevant to the region. As a first concrete product of that intensified cooperation, a joint proposal was submitted in October last year for building block 3 of NFG LLO Cataly<sup>24</sup>

<sup>23</sup> <https://www.werkinzicht.nl/nationaal-programma-groningen-werken-aan-ontwikkeling/>

<sup>24</sup> <https://llokatalysator.nl>

Last but not least, it is then up to governments. Not only nationally, but also regionally; and in the Northern Netherlands as a whole and Groningen in particular, energy transition has been an important spearhead for economic development for decades. This is detailed in the RIS3. But the energy transition also raises regulatory questions for governments; and competence development of government personnel regarding the energy transition and (changed) regulatory needs is therefore also part of regional human capital agenda that we are developing (for example, from the lectorate Legal and economic issues within the energy transition).

Besides energy, human capital is also an important pillar for socio-economic development in which to invest. For the Northern Netherlands, the three Northern labor market regions are jointly drawing up a human capital agenda with partners.

In the labor market region of Groningen (which includes North Drenthe), economy-wide, including funds from the National Program Groningen (NPG), additional investments are being made to translate educational and labor market challenges into increased labor force participation and productivity, thriving business activity, resulting in broad prosperity in a thriving region.

Renewable Energy is one of the three major thematic transitions for economic structure strengthening within the NPG. The Just Transition Fund (JTF) is an additional impetus for the same goals as the NPG, also with energy and sustainability as fundable themes. With *Nij Begun* comes an additional impetus, with measures relevant to hydrogen applications<sup>25</sup> :

- *Measure 35: There will be an Economic Agenda for Sustainable Growth.*
- *Measure 35.1: Groningen will become the hydrogen province of the Netherlands: at least 33% of the yet to be constructed capacity of Wind at Sea will land in the Province of Groningen'*
- *Measure 35.3 The Cabinet is investing € 15 million in improving the business and business establishment climate in the Northern Netherlands, of which € 10 million for the NOM and Economic Board Groningen and € 5 million for support in utilizing existing schemes and financial flows.*
- *Measure 35.4 €100 million will be made available to support strategic international activity. attract to the region.*
- *Measure 35.5 The Ministry of Economic Affairs is setting up a special team to stimulate innovation, employment and economic development in Groningen and North Drenthe.*
- *Measure 35.6 In the next round of applications for funds from Regio Deals, funds will be released to honor two proposals from Groningen and North Drenthe, worth a total of €50 million.*

#### **4.2.1 Conclusions Action perspective**

The Northern Netherlands is a frontrunner in green hydrogen, and the region, with major support from regional governments and knowledge institutions, already has the necessary infrastructure in many relevant aspects (from knowledge development to training and labor market programs). Supporting and further accelerating business investment in the tilt to hydrogen and the development of the associated human capital is now the top priority. Minimal coordination, and possibly even formal cooperation of companies with (public) support and partners seems to be the most important means. The split of simultaneous substantial product innovation, market development (in a still early phase) and already rapid personnel growth in a tight labor market justifies this. With at least the aforementioned

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<sup>25</sup> Nij Begun: towards recognition, recovery and perspective, Ministry of Economic Affairs and Climate, online: <https://www.rijksoverheid.nl/documenten/kamerstukken/2023/04/25/nij-begun-op-weg-naar-erkenning-herstel-en-perspectief>

examples and the partners involved, we want to further develop the necessary instruments for this purpose. It is therefore relevant that the financial instruments of GroenvermogenNL can support precisely that kind of, less common, project and program development. (For example) a simple training subsidy for sitting employees alone will not solve the main problems.

## 4.3 Overview of initiating projects and planned activities

### 4.3.1 Investment agendas

To make energy and resource supply more sustainable, the use of emission-free hydrogen is crucial. In that light, in 2019, companies and governments in Groningen and Drenthe drew up an industrial hydrogen investment agenda, which was later expanded into an [investment plan](#) of over EUR 9 billion. Central to this is the (further) development of a hydrogen ecosystem, also taking into account the sectoral transitions to green jobs and the further development of hydrogen knowledge. The plan foresees partly to initiate activities in the hydrogen chain (up-, mid-, downstream) (up to 2025, up to 100 MW) and partly to close and scale up the chains (2030, GW-scale installations). The agenda addresses national policymakers with a number of recommendations around instruments (inclusion of hydrogen production in SDE scheme, integral consideration of value chain, setting up legal frameworks). This plan has laid the foundation for the further expansion of the Hydrogen valley Northern Netherlands with leading programs HEAVENN, Hydrogen Network Netherlands and NorthH2. Since 2020, the expected portfolio has continued to expand both in scale and estimated investment size. Further programming around hydrogen is ongoing through, among others, the Baanbrekers within the NPG in which the hydrogen economy and circular economy are important pillars, and *Nij Begun*, in which green hydrogen becomes an integral part within the economic agenda for sustainable growth.

### 4.3.2 HEAVENN

HEAVENN (H2 Energy Applications in Valley Environments for Northern Netherlands) is the first as such Hydrogen Valley funded by the EU-Clean Hydrogen Partnership. The program has a strong focus on developing large-scale demo projects that promote the closing of green hydrogen chains in the Northern Netherlands through interdependence.

**The activities are divided into 4 clusters:**

- **Chemiepark Delfzijl:** local hydrogen infrastructure Groningen Seaports, 60 MW of electrolysis capacity, greenemethanolproducte (20 MW), greenerkosineproduction (60 MW), filling station for hydrogen trailers, hydrogen-powered inland shippinghcip.
- **Emmen Industrial Park:** Redevelopment GZI Emmen to GZI Next Energy hub (4 +6 MW electrolysis capacity), pipeline to GETEC Park Emmen, filling station for freight and bus transportation.
- **Storage and built environment:** underground hydrogen storage EnergyStock Veendam, Hydrogen district Hoogeveen (100 new homes, conversion of 427 households from natural gas to hydrogen), hydrogen-powered emergency power supply Bytesnet data center (100 kW fuel cell)
- **Sustainable mobility:** water refueling stations, hydrogen trucks and buses

The above subprojects will accelerate new technology (generation, storage, fuel cells) to become an integral part of the energy system. Through flanking replication and impact studies, HEAVENN thereby provides an international blueprint for the green hydrogen business model.

*Status:* program ongoing, 2020-2026

*Partners*<sup>26</sup>: New Energy Coalition, Nobian, Gasunie, Groningen Seaports, Shell, Engie, Total Energies, among others.

#### **4.3.3 Hydrogen Network Netherlands (Hynetwork Services)<sup>27</sup>**

Scaling up the hydrogen economy requires (inter)national interconnection of (industrial) clusters in which production, transport, storage and use are integral parts of the process. At the end of June 2023, Gasunie took an investment decision to connect several industrial clusters, ports, large-scale storage units and international interconnection points through a national hydrogen transport network until 2030. About 85% of the transport network is expected to consist of recycled natural gas infrastructure. The transmission grid is expected to reduce the uneconomic top of further investments and thus drive the use of green hydrogen both as an energy carrier and as a feedstock.

*Status:* ongoing

*Partners:* Gasunie (Hynetwork Services), TenneT, EKZ,

#### **4.3.4 North2**

Establishing an ecosystem around green hydrogen requires large-scale production from green electricity. Scaling up renewable energy (wind farms, PV farms, nuclear power) goes hand in hand with scaling up electrolysis capacity. North2<sup>28</sup> is a stepped program in which a feasibility study is first conducted into the production of green hydrogen in combination with large-scale electricity production from offshore wind. This will provide insight into optimal placement and sizing of infrastructure (e.g. offshore conversion to hydrogen, transportation via pipelines in the sea). One foresees the development of the offshore energy hub by 2027, 4 GW of electrolysis capacity by 2030 and scaling up to 10 GW by 2040.

*Status:* feasibility study completed

*Partners:* Shell, RWE, Equinor, Eneco, Groningen Seaports, Province of Groningen

#### **4.3.5 Test and research facilities**

Where normally development cycles of several decades are not excluded for new technology, new hydrogen technology requires accelerated integration and scaling up in our energy system. This requires test, training and research facilities where together (multidisciplinary and multilevel) the workability, feasibility, acceptability and safety of hydrogen systems are investigated and taught. The northern Netherlands stands out with a number of state-of-the-art laboratories in the field of renewable gases and fuels:

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<sup>26</sup> <https://heavenn.org/partners>

<sup>27</sup> <https://www.hynetwork.nl>

<sup>28</sup> <https://www.north2.eu/>

- **Energy Conversion laboratory** (RUG, TRL 3). Development of new materials and setups for fuel cells, among other things.
- **Digital Twinning** (Hanze Hogeschool, TNO, RUG, TRL 4): operational optimization and control of integrated energy systems.
- **Energy Transition Bridge** (Hanze University of Applied Sciences, TRL 5): modular and safe testing of integrated energy systems for SMEs, among others.
- **Hydrogen Innovation Network Groningen** (WING) (Hanze University of Applied Sciences, TRL 5): modular and safe transport network hydrogen for experimental and educational applications.
- **REMO lab** (Hanze Hogeschool, GasTerra, TRL 5): experimenting with the production of renewable gases and circular chemicals.
- **Hydrohub MW test center** (Hanze Hogeschool | ISPT | TNO, TRL 6): 2 x 250 kW electrolyzers for optimizing and scaling up green hydrogen production
- **DNV Technology Centre Groningen** (DNV, TRL 7): scale-up, validation and certification of technology for gas applications > 200 kW
- **Water Campus** (Wetsus, RUG, CEW, NHL Stenden, HVHL, Firda, TRL 2-8) Development of saltwater electrolysis, system integration water chain & energy chain.
- **Greenwise Campus Emmen Innovation Center** (TRL5-7) hydrogen lab and research center around safety, inspection, maintenance and failure behavior.
- **DOC33** at Alfa College in Hoogeveen, focusing on hydrogen in the built environment, public education and training of installers in hydrogen boilers. Goal is to set up expert center on sustainable heating with hydrogen

## 4.4 Regional Human Capital Development

### 4.4.1 Hydrogen Works

To successfully complete the transition from a natural gas-driven economy to a green-hydrogen economy, the availability of sufficient skilled people (quantity & quality) in the region is crucial. This will require a supply of new continuous learning lines (MBO, HBO, WO) and post-initial courses in which companies and training institutions work together. Hydrogen Works provides an impetus by working on, among other things, internships in MBO, in-service training, projects and research activities to train 1,000 hydrogen professionals. This program was recently expanded in terms of content scope (green molecules for energy and raw materials transition), objectives (2,000 trained professionals in 2027) and duration (until 2027).

### 4.4.2 Green hydrogen booster

For SMEs, applying hydrogen in business processes requires innovations. In addition to these innovations being risky (payback unclear, high investment costs, missing markets and changing government policy), knowledge and facilities to test the workability of hydrogen innovations are lacking. To support scale-up within SMEs, the Green Hydrogen Booster (GWB) has been set up in the Northern Netherlands. This is a public-private program through which companies devise, test and validate innovations through vouchers with knowledge institutions and other companies.

Here learning for SMEs, demand articulation and innovation go hand in hand. The GWB has vouchers of 5k and 15k (20% and 30% co-financing, respectively). After an approval process, companies can count on technical support, deployment of professionals from the GWB network and training facilities from the knowledge institutions. The GWB has already carried out 30 vouchers and has meant the first steps towards the application of hydrogen for many SMEs. In order to maintain this flywheel function, a larger variant of this voucher scheme has now been created.



*Status:* GWB will be completed in its current form by the end of October 2023.

*Partners:* Hanzehogeschool(Lead), regional partners, SNN, EKZ

#### **4.4.3 Green powerNL Train the Trainer program**

The integration of hydrogen in the energy system, process industry and mobility sector requires sufficient theoretically and practically trained technicians, as well as teachers with sufficient skills to train or retrain current and new professionals. Based on the MBO cooperation in the Northern Netherlands, Energy College, the teacher professionalization pilot was started within GroenvermogenNL.

**The objectives of this pilot are to, specifically:**

1. To give new teachers a good foundation to teach the hydrogen subject, and to that end, be taught by content-area professionals.
2. Identify key hydrogen applications within the region
3. identify the knowledge and competencies present and needed
4. Identify what facilities and training are needed for teachers
5. establishing teacher and student development programs.

Follow-up steps are to further develop (breadth) and scale up the process nationwide.

#### **4.4.4 Greenskills 4 Hydrogen**

The development of the green hydrogen economy is accompanied by labor market challenges, European and in regions with shrinking sectors. The Erasmus+ funded program Greenskills4Hydrogen<sup>29</sup> focuses on up-skilling and retraining pathways for students and professionals by developing, among other things.

- Modular training courses
- Establishing a hydrogen community
- Training standards for green hydrogen
- Improved access to LLO materials
- Promotional materials for the hydrogen sector

Underlying this is the demand articulation collected from over 200 stakeholders. From there, current and future hydrogen professionals are being profiled and a special program for continuing and retraining is being worked on for each group.

*Status:* ongoing (2022-2025)

*Partners (NL):* Drenthe College, NHL Stenden

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<sup>29</sup> <https://greenskillsforhydrogen.eu/>

#### 4.4.5 Hydrogen Valley Campus Europe<sup>30</sup>

The complexity of the innovation issues surrounding green molecules requires a multi-level infrastructure that cleverly combines learning, working and innovation. Joint experimentation and training facilities are crucial here. Further development of these facilities in the Northern Netherlands is necessary to better anticipate future developments and build on the leading position on the international stage. HVCE (Hydrogen Valley Campus Europe) is the program whereby the knowledge ecosystem of regional campuses and training centers are further integrated and stimulated.

##### Spearheads of HVCE are:

- **Knowledge development.** (R&D in green molecules, LCs)
- **Agenda-setting and programming.** (Roadmapping, collaboration top energy sector)
- **Internationalization** (hydrogen valleys, international replication and exchange)
- **Integrated testing and training facilities** (multi-level collaboration, faster scale-up TRL 4 → 8 )
- **Business hub** (regional impact enhancement, SME voucher scheme, networking, civic participation)
- **Training development** (MOOCs, matching tooling, connecting continuous learning lines)
- **LLO** (energy and resources)

In October 2023, funding from the JTF (Labor Market Transition Grant) launched the H2 Train & Learn hub program.

##### The scheme aims to achieve the following goals:

- Encourage training for people who can and want to work.
- Encourage learning culture in people and in companies.
- Link training, participants and businesses.
- Improve starting position of young people.
- Improve connection of training to labor market demand.

##### To this end, the following activities are being developed within the H2 Train & Learn Hub program:

- Expanding the learning activities and facilities from the previous program Hydrogen Works!
- Educational offerings hydrogen and green molecules.
- Applied and fundamental knowledge development.
- Apprenticeships, traineeships and internships.
- Challenge-based learning, connecting education and business.
- Encourage training and development LLO.
- Strengthening Practor-Lector-High Professor Connection.
- Knowledge sharing and public activities.

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<sup>30</sup> <https://www.rug.nl/wubbo-ockels-school/research/hydrogen-centre/collaboration/>

While the formation of HVCE is ongoing, a number of facilities are already under construction. Follow-up steps focus on a practical structure for collaboration between companies and WO, HBO and MBO organizations, effectively linking to other regional and national programs, the various North Dutch locations and facilities, and the development of supportive policies (labor market, housing and location climate).

#### 4.4.6 Hive.Mobility

Hive.Mobility is the innovation center for smart and green mobility solutions for passenger and freight transport in the Northern Netherlands<sup>31</sup>. One of options for sustainability is hydrogen. Ranging from drones to cargo bikes, buses, trains and garbage trucks, projects are now underway in every modality on the application of hydrogen. Within Hive.Mobility, the Hive Mobility Center is being developed, a place where professionals share and further develop their knowledge and applications, students conduct research or are trained, and employees undergo further training or retraining. The innovation center will also be open to the public, both professionals and residents, so that everyone can see and experience what is happening in our region in the field of smart and green mobility. Hive.Mobility and its partners are currently working on the concept development and realization of the Hive Mobility Center. The program around the center will be modular, allowing for easy growth with need.

#### 4.4.7 Greenwise Campus Emmen

Greening and smartening up in the region around themes such as circular plastics, Energy, Smart Manufacturing, Welfare/Care/Technology is bundled in the program Greenwise Campus<sup>32</sup>. This involves companies, educational organizations (multi-level) and governments joining forces and collaborating on green and smart solutions for today and tomorrow.

Within the Energy program there is multidisciplinary cooperation on the energy transition, particularly in industry and other activities in the region around Emmen. Examples are (the use of) hydrogen, green gas and smart business with energy. The focus is not purely on the technical aspects, but also on the human side of the energy transition, including the social and economic impact (connection, valorization, agenda-setting, development).

*Status:* started fall 2023.

*Partners:* NHL Stenden, Drenthe College, University of Groningen, Province of Drenthe, Municipality of Emmen, University of the North

#### 4.4.8 Other projects, initiatives, programs

- H2COVE (Hydrogen Vocational Centre of Excellence): replication of regional HCA initiatives to other European regions (e.g., train the trainer, knowledge sharing, develop modular curricula for specific functions, engage target groups with disabilities in hydrogen functions, industry specific education modules). *Awarded, start March 2024*
- LLO Catalyst building block 2 and 3: LLO for energy and resources. *Awarded, start in 2024*
- Growth plan scaling up PPP, green transition in water, chemical and food<sup>33</sup>: Thematic cross-sectoral collaboration of chain partners based on Learning Communities. *Starts autumn 2023*

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<sup>31</sup> <https://www.hivemobility.nl/>

<sup>32</sup> <https://greenwisecampus.nl/>

<sup>33</sup> <https://netwerk.wijzinkatapult.nl/detail/1298/groene-transitie-in-water-2c-chemie-en-food/netwerk-digitalisering-alles-hcaict-growth fund/>

## 4.5 Learning Communities

The complexity of transition issues is characterized by their scale, unpredictability and the speed with which knowledge (competencies, innovations) must be available. Traditional forms of learning are often too reactive and that does not fit with the dynamics of processes in which the demand articulation, results and available instruments are unclear at the front end. So other forms must be looked at to address human capital issues. Professionals themselves will have to learn to act adaptively, proactively and self-developingly in the innovative sectors in which they work. Solutions can thus be found in processes in which we combine working, learning and innovation. Professionals and students from education, research, government and business do this together in learning communities (LCs). Within ENTRANCE, LCs are organized as a group of people who work together from different roles and backgrounds to solve common research or innovation questions from research (professors, researchers, students) or practical issues from companies and social organizations. As the leader of a national project commissioned by Top Sector Energy on the theme System Integration<sup>34</sup>, ENTRANCE has now accumulated a lot of experience and knowledge about running LCs. The learning and innovation results from these LCs flowed back to all participants and associated stakeholders. This appears to be an organic process where, for example, a practical problem is solved. Outputs are processed into knowledge products (modules, data) and made available to participants and third parties. For the concept phenomenon of learning community to contribute well to human capital development for hydrogen, scaling up of the current LCs at, for example, Holthausen Clean Technology and the HYDROGREENN<sup>35</sup> network is needed. More LCs are needed, more multidisciplinary in nature and more versatile in the (cooperation between MBO-HBO-WO students and professionals.

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<sup>34</sup> <https://topsectorenergie.nl/nl/projecten/learning-communities-systeemintegratie/>

<sup>35</sup> HYDROGen Green Regional Energy Economy Network Northern Netherlands. HYDROGREEN spans 320 organizations and 430 members. Coordination is organized within the Green hydrogen booster by ENTRANCE and Greenwise Campus.

# 5 Future Regional Program and Activities for Green Hydrogen

The ambient exploration has painted a picture of the current situation and future challenges for the various *perspectives* (employers, employees, companies, government, social organization and knowledge and educational institutions), *sectors* (industry, built environment, transport and distribution, mobility) and place in the *green hydrogen chain* (upstream, midstream, downstream). With keywords such as collaboration, learning, innovation, entrepreneurship and scaling up, what follows is an overview of the programming needed to achieve a responsive regional green hydrogen labor market that will enable this sustainable, social and economic development to take place.

## 5.1 Campus integration: including H2 Knowledge & Innovation Hub

From the perspective of knowledge institutions, multidisciplinary, multi-level working, learning and innovation requires a meticulous cohesion of campus facilities, such as laboratories and learning and experimentation facilities (fieldlabs).

**The H2 Knowledge & innovation Hub forms, organizes and coordinates this and covers such areas as:**

- Campus organization and management, with a structure that maximizes the use of available testing, learning and experimentation facilities for educational curricula and research programs
- Development, modernization and expansion of shared learning and experimentation facilities (e.g. Zernike Campus Groningen (ENTRANCE), Greenwise Campus Emmen, EnergieHub050)<sup>36</sup>
- Access and impact in the region: establish public-private partnerships around these shared facilities. SME partners will have access to initiate, realize and scale up innovation in hydrogen applications.
- A (digital) platform with tools for setting up and designing multidisciplinary tests and experiments at 1 or more of the sites.

The start-up activities (2024-2027) for this are now being shaped within the JTF program.

## 5.2 Scaling up Learning Communities Hydrogen

In the Northern Netherlands, on top of the ongoing LCs hydrogen, a further professionalization and expansion effort is required to sustainably and structurally create a work-learning-innovation ecosystem.

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<sup>36</sup> <https://www.alfa-college.nl/bedrijven/energiehub050>

come that accelerates closing green hydrogen value chains and gathering hydrogen competencies (*employer perspective*).

**To this end, a number of goals are set:**

1. Increased number of students on the topic of hydrogen.
2. Increasing the number of students participating in micro LCs to meso-LCs
3. Developing more and more extensive cooperative agreements with partners, along the lines of the Green Hydrogen Booster.
4. Circulate and make available new knowledge for the hydrogen chain. In addition, connecting knowledge to learning paths and other forms of knowledge transfer.
5. Self-evident cooperation between MBO, HBO and university.
6. To further embed the facilitator role within the process of developing an LC on, implementing and valorizing knowledge.
7. Validating the concept of LC as a vehicle to reduce 1) time-to-job and 2) streamline collaboration within a problem that requires a multi-disciplinary approach.

We are building on experiences with learning communities within MMIP13<sup>37</sup> (systems integration). They are validated for (domain-specific) hydrogen applications and then scaled up in size, complexity and number.

### 5.3 Groundbreakers within National Program Groningen

The developments within NPG are widely supported regionally by administrative bodies (government, knowledge institutions, companies, employers). Currently, the program for the next few years is being developed, and two of four *trailblazers* identified therein<sup>38</sup> are relevant to human capital agenda-setting within GroenvermogenNL:

- **Energy:** further developing hydrogen economy, making industry more sustainable, accelerating regional heat transition, congestion management business parks
- **Education and Labor Market:** investments for a well-functioning labor market in the fields of energy, health and rural areas, support for cooperating parties and contribute to the fulfillment of good employment practices.

HVCE forms the basis for a strong cooperation in the field of green molecules and is aimed at implementing the hydrogen investment agenda. This cooperation is aligned with national and regional companies and will be successful if MBO, HBO, WO and post-initial activities are closely aligned. However, this is not enough: to sustainably and structurally strengthen the knowledge and innovation energy and raw materials transition in the region, it is necessary to more closely intertwine activity, education, knowledge development and policy with campus developments with the main spearheads:

<sup>37</sup> <https://topsectorenergie.nl/nl/maak-kennis-met-tse/systeemintegratie/innovatieprogramma-mmip13-een-robust-en-society-borne-energy-system/>

<sup>38</sup> <https://www.nationaalprogrammagoningen.nl/baanbrekende-programmas/>

- **High development:** an investment and development environment around green molecules that seeks international impact and excellence (*employer perspective*).
- **Breadth development:** appealing locations that bring creativity, craftsmanship and dynamics around hydrogen under one roof and thus boost innovation and start-ups (e.g. dreamhalls). (*perspective employers and employees*)
- **Depth development:** flanking policy and programming to boost the attractiveness of the Northern Netherlands as a region to work and live in (radiation to other sectors) (*government perspective*)

Developments within NPG/job breakers are widely supported regionally by administrative bodies (government, knowledge institutions, employers).

## 5.4 Lifelong Development

There is already a broad portfolio of LLO offerings for lateral entrants offered by collaborating Northern Netherlands knowledge and educational institutions. However, this portfolio can be optimized and expanded on the basis of 1) demand articulation among SMEs in the region for a future-proof learning culture and 2) the (free) choice of the individual who wants to follow an optimal route in a (combined) educational route or labor market route.

**To establish and future-proof the innovation impulse, the following activities and results are envisaged:**

- Establish structure and process for ongoing demand articulation
- Strengthen cooperation within SME clusters.
- Develop, test, validate innovative, smart, accessible learning and development variants
- Flexibilize and develop accredited (micro-credentials) LLO modules around energy and resources.
- Location-independent learning (MOOC<sup>39</sup>s, SPOCs) at the MBO and HBO level
  - Laws and regulations (*government perspective*)
  - Risk management and safety procedures
  - Operations and maintenance in the hydrogen chain
- New ways of learning, working and innovating.

A number of activities are under development as part of Building Block 2 (LLO Catalyst) with a timeline to mid-2027.

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<sup>39</sup> MOOC: Massive Online Open Course; SPOC: Small Private Online Course

## 5.5 Regional Cohesive Approach

Scaling up the hydrogen economy requires far-reaching cooperation between all perspectives on the labor market. In addition to administrative traction, this requires governance structures that secure long-term public-private cooperation within which we, among others:

- Giving continuity to regional developments that serve a national interest (scaling up, replication)
- Create regional agenda setting and programming around green molecules and circular raw materials
- Sharing and valorizing knowledge and products
- Structural assurance and renewal of national hydrogen knowledge platform
- Give hands and feet to demand articulation among employers and employees (networking, events)
- Coordinate ongoing research, design, development
- Aligning national programs and outlooks with regional needs

Existing programs and projects often have too limited impact and offer too little continuity. However, this is much needed, also for consistency with national programs and the structural impact of all HCA initiatives we take.

## 5.6 Research and development

**For the coming years, the following topics, among others, are central in the field of (green) hydrogen:**

- Cheaper production of green hydrogen (TNO, ENTRANCE, MegaWatt Test Center ENTRANCE, Water Campus Leeuwarden)
- Transport, distribution and use of hydrogen (including Gasunie, DNV, RuG, ENTRANCE , WP2 and WP3 GroenVermogenNL)
- (digitally) linked experimentation and training facilities (ENTRANCE, RUG, GREENWISE)
- Integrating hydrogen production into processes around the water chain and heat demand in the built environment (Water Campus, RUG, HANZE).
- *Leading international* research in legal aspects, fuel cell development, experimental scale-up, integrated energy systems and techno-economic frameworks.
- Develop and scale up methods around circular raw materials and processes (RUG, HANZE, REMO lab, Water Campus).
- Advancing (small-scale) innovations in SMEs (MBOs, ENTRANCE)
- Innovation in education and training methods such as VR, virtual control rooms, virtual maintenance training, small-scale demonstration setups
- Failure Behavior, Inspection and Maintenance of Hydrogen Plants (GREENWISE campus).



## 5.7 Improved positioning of MBO institutions

Completed and ongoing initiatives to enhance the training portfolio for secondary vocational education (both BBL and BOL) have resulted in promising and scalable hydrogen training packages, both for mobility, industry & networks and the built environment. Further (national) replication, improvement and expansion of the portfolio requires collaboration and development in a multi-level and multidisciplinary setting.

**Here a discrepancy occurs between the societal desire and high demand for practically (re)trained technicians and the development capacity that is often lacking to develop on a larger scale, among other things.**

1. recruit new students
2. establish facilities for future technicians,
3. embed innovative ways of working, learning, innovating in practical education
4. establish sustainable cooperation with business, knowledge and educational institutions.

A habit and culture needs to develop whereby MBOs can coordinate these types of initiatives on a large scale. One of the means for this is to make common funding instruments compatible with the activities and social knock-on effects of MBOs. In the shorter term, we foresee one (or more) pilot(s) in which, from the perspective of employers and educational institutions, the MBOs will develop multilevel curricula as the focal point. This will provide insight into how processes run and can be improved and ultimately, from a practical perspective, give human capital development a lasting boost.

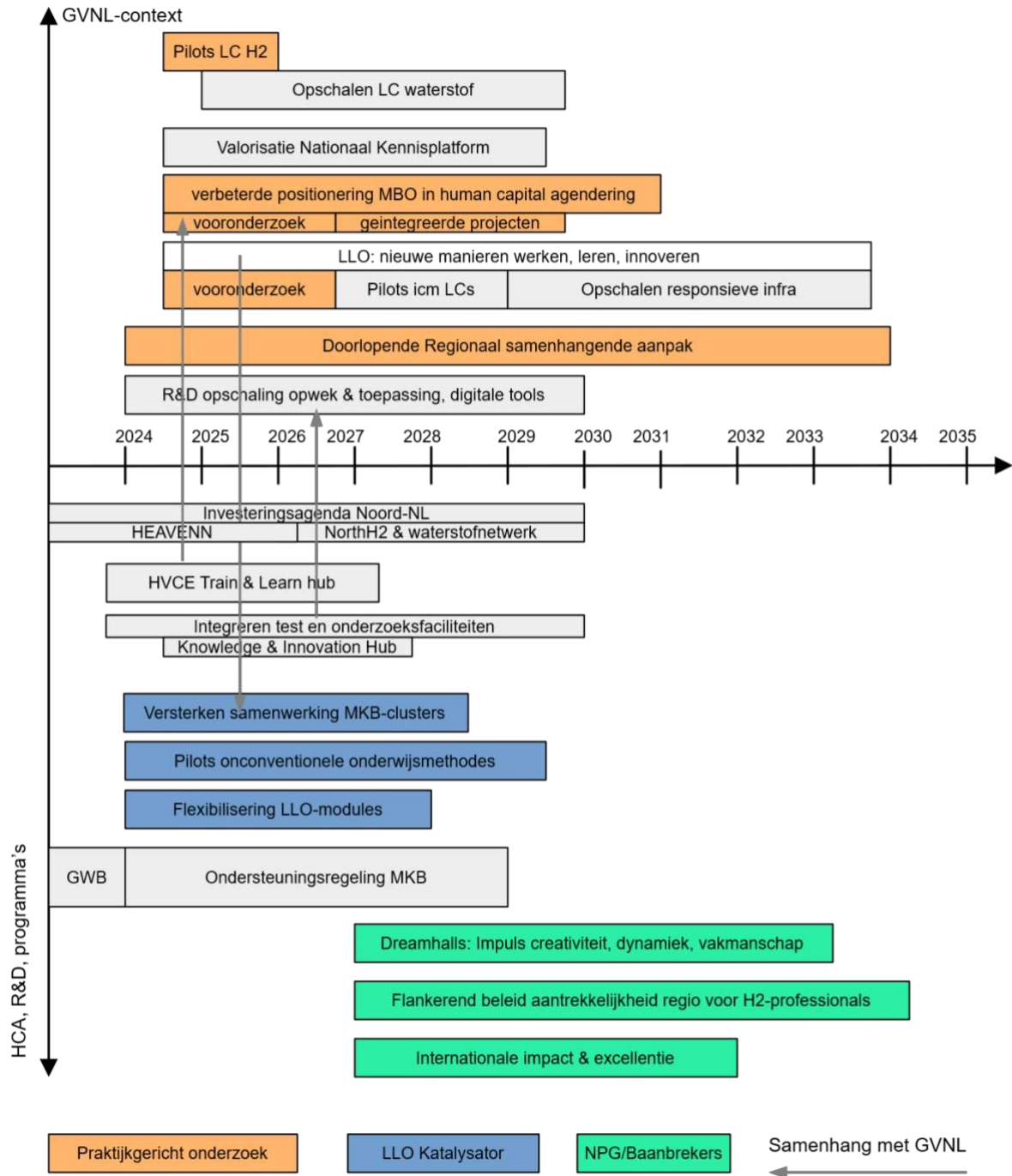


Figure 7 Future HCA activities Goenew hydrogen chain in Northern Netherlands and the positioning of GroenvermogenNL within it.

# 6 Regional impact with GVNL

**Given the current (labor) market situation, ongoing initiatives and planned activities within the Northern Netherlands, we distinguish 6 HCA pillars with which we want to create broad knock-on effects in our region together with GVNL:**

1. Ongoing regionally coherent approach
2. Valorization National Hydrogen Knowledge Platform
3. Improved Positioning of MBO in HCA green hydrogen
4. Scaling up LCs Hydrogen
5. LLO & new (integrated, time- and location-independent, digital, multimedia) ways of working, learning, innovating
6. Research and Development (linkage with Human Capital agenda-setting)

Here we briefly describe what the North Netherlands wants to develop within these pillars and the knock-on effects of the products and results in the sectors.

## 6.1 Pillar 1: Continuous Regional Coherence Approach.

### **What:**

The network around green hydrogen development in the Northern Netherlands is strong and diverse but also still sometimes fragmented. Partly because different sectors such as industry, mobility, knowledge and educational institutions work from their own perspectives and worlds. This sometimes leads to a lack of connection and cohesion and sometimes to unintended overlap in programs.

In addition, crucial activities risk falling between the cracks. Also because international, national and regional funding programs and instruments seem insufficiently aligned. Better defining roles, objectives and human capital services of the regional chain partners from different perspectives is therefore a crucial starting point to deal more efficiently with government instruments and human capital development.

**More efficient here means: there is a process framework for scaling up/initiating hydrogen projects that includes.**

- For each process step, it is clear what funding instruments are available, what private should be funded and where any risks lie
- Competency questions are identified on an ongoing basis
- Innovation needs reach knowledge institutions faster
- Cohesive private and public administrative coordination on energy transition and circularity (thus prominently including the hydrogen transition) is needed.

Coordination with national stakeholders is necessary here: it is in the national interest that there is no delay in scaling up/scaling out applications of green hydrogen (production, storage, transport, use). Nor on the training offer and knowledge development.

Because critical parts of hydrogen chain are not yet technically mature and thus it is relatively expensive for companies to switch to hydrogen applications, it is difficult for them as

dependent chain party to take the initiative-while precisely those accelerations are desirable. Therefore, the regional liaison team sees this as an important objective.

#### **Some knowledge questions involved are**

- How does green hydrogen chain development relate to public-private partnerships in the region?
- How can knowledge from learning communities best be valorized?
- How can rapidly changing technology (green hydrogen) find its way easily and flexibly into continuous and post-initial curricula?

#### **Follow-through:**

- Continuous adjustments (and documentation) of competency question
- Lower risk in green hydrogen technology investments
- Coherent green hydrogen approach provides critical mass for SMEs to invest in applications using hydrogen as a feedstock or energy carrier (instead of fossil)
- Regional developments are adopted (inter)nationally
- (inter)national frameworks/developments countries easier in the region

#### **How:**

We envision 2 partnerships that roughly continue the liaison function and expand the knowledge dissemination around (green) hydrogen, respectively.

## **6.2 Pillar 2: Valorization National Hydrogen Knowledge Platform.**

#### **What:**

In early 2024, the first prototype of the national green hydrogen knowledge platform will go live. The content shown consists of already existing content and comes from platforms such as the Green Hydrogen Booster, Ozone and MBO, among others. This completes the first start-up part of the knowledge platform. To make the knowledge platform successful, it is necessary to provide it with content on an ongoing basis, respond to users' needs, and implement technical improvements (maintenance, security). The knowledge platform will also be fed by the knowledge obtained from the Learning Communities, thus becoming a vehicle where knowledge is brought and retrieved. An important goal here is to obtain sufficient critical mass to eventually raise funding from private parties.

#### **Functionalities of the Knowledge Platform that can be developed are:**

- Education (courses, training, virtual events, personalized learning paths)
- Provision of information (reports, articles, information on technology development, regulations, ongoing projects, news, access to external sources)
- Collaboration (discussion forums, responding to news, facilitating learning communities)

### **Follow-through:**

**After the start-up phase gets good operational follow-through, the national hydrogen knowledge platform continues to work along several axes**

- Flexible training modules lead to more diverse educational offerings, specialized where needed
- A supported portfolio of knowledge articles, referrals to training modules, MOOCs, SPOCs, retraining opportunities generally increases national coherence between activities carried out in the region
- Leading counter for gathering knowledge on green hydrogen preferred to call it facilitation

### **How:**

To make and keep the (digital) platform supported, there will have to be continuous demand articulation from the field (SMEs, network operators, large industry, governments) about expected developments in the (labor) market and the need for training. This part takes place through the regional liaisons (pillar 1). The creation of content (=supply of information) is in cooperation with connected knowledge institutions, companies and governments. Costs for this will ideally have to be paid out-of-pocket. Maintenance of the platform (posting content, interaction with users, technical maintenance) takes place in the knowledge platform team.

## **6.3 Pillar 3: Improved Positioning of MBO in HCA green hydrogen**

### **What:**

In current and future programs, the MBO can be helped to accelerate the change that has already been going on for two decades in the HBO (that of lecturers, practice-oriented research and innovation) within the MBO (in its own form through practories). Besides new and innovative offerings for students, creativity, innovation and volume are needed to have offerings for professionals from MBO (together with HBO and WO) available for the energy transition sector. The greatest effect for the energy transition and thus social **impact**<sup>40</sup> is achieved by retraining, re-training and upskilling professionals from different labor market sectors. The culture change will give human capital development at the MBO level a lasting boost.

### **How:**

Through practicals, development capacity within MBO is strengthened. Practories aim to accelerate the demand driven by the business community, to build new training offerings in consortia and to strengthen further internal partnerships. In order to make this concept workable in practice, we foresee one or more pilots in which the MBO takes the lead in close cooperation (developing offerings together, drawing up strategy) with learning communities, other regional MBO institutions and development activities within the LLO catalyst. Here we foresee a start-up phase in which together with HBO, which has already gone through such a transition, outline frameworks for implementation in MBO. Afterwards, this will be operationalized as a pilot in ongoing courses within one of the affiliated MBO institutions. Moreover, an ongoing cycle should be set up in which the course is evaluated together with HBO institutions. If successful, it can be scaled up further (more complex courses, more labs).

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<sup>40</sup> The terms impact and knock-on are used synonymously in this roadmap

## 6.4 Pillar 4: Scaling up LCs Hydrogen

### What:

Learning communities in the field of hydrogen help to give the hydrogen economy a boost: knowledge enters the business world earlier, students become familiar with implementing hydrogen in a business model at an early stage, and experiences from the learning communities can be used for research into hydrogen applications at an early stage. Because in the market these applications are still in their infancy, this flywheel can only start to turn if the *facilitator role* for learning communities gets a boost. Then pilot micro LCs can become an example for setting up (more complex) macro LCs. Scale and number helps here because the quality of setting up and operationalizing LCs is an ongoing process. Eventually, the learning community concept will become embedded in the playing field where green hydrogen is worked, learned, and innovated.

### Follow-through:

Research-based work, innovation and learning in the quadruple helix have shown that learning communities have a knock-on effect on competency development in knowledge institutions (project-based work, demand-driven programming, mastery of professional competencies), governments (approach to energy transition), and business (knowledge about innovations reaches the shop floor faster). Innovations and knowledge reach the business community sooner, students become familiar as early career professionals with the desired professional competencies and the broad context of hydrogen in a business model, and experiences from the learning communities can be used at an early stage for research on hydrogen applications. This is qualitatively validated for (green) hydrogen. In summary, knowledge gets to the relevant stakeholders earlier and companies use learning communities as a means to meet the competency needs for green hydrogen (time-to-job).

### How:

The main activities are to continue existing pilot LCs and to facilitate new LCs in the field of hydrogen or at the interface with other energy carriers/raw materials.

Knowledge development, renewing course offerings and project support are thereby activities that are needed on an ongoing basis for knowledge and educational institutions. Governments and companies will have to invest time and thus financial resources in the participation of LCs. Especially in the start-up phase (micro-LCs, wishful thinking) it is desirable that leave costs can be financed here.

### Because of the pilot nature of green hydrogen, practical researchers will work on the research questions below:

- What is a workable process for validating the impact of learning communities?
- How can the knock-on effects of learning communities be applied cross-domain?
- How much is time-to-job reduced if projects take place in a learning community framework?
- How should the facilitator role from regional LC hydrogen pilots be adapted for scale-up (complexity, size) and quantity?
- What labor-saving innovations are possible to make LCs more successful?
- what is a workable process for making new knowledge from the learning communities available to the hydrogen chain

Leading to improved facilitator roles and expectations within multidisciplinary working groups. Both optimized from systems integration and focused on green hydrogen.

## 6.5 Pillar 5: LLO & New ways of working, learning, innovating

### What:

The speed with which knowledge in general and new technology in particular must find its place in the hydrogen chain (business perspective) can only be guaranteed if this knowledge finds its way smoothly (=quick, easily accessible, available in time) into the (re)training needs of employees. Employees who, in turn, want an increasingly flexible training offer (continuous, not time-bound, not location-bound). Because this goes beyond the traditional way of (re)training, we will investigate unconventional ways of competence acquisition and educational development and test them in a pilot against the wishes of employers and employees. This is in line with the activities within the framework of the LLO catalyst, where we state that in GroenvermogenNL the focus will be on practically exploring ways to accelerate time-to-job.

### Follow-through:

Compared to traditional ways of upskilling and retraining, which, although demand-driven, often goes through a linear process and assumes *market demand* → *competency demand* → *training demand* → *training*, one expects that with unconventional methods 1) demand management will more easily find its way finds in the training offer and 2) employees in the future have a need to be more flexible in their learning. Together, this reduces the *time-to-job* once there is a market demand from the employer perspective (compared to conventional continuing education).

### How:

We envision developing unconventional LLO methods in a few steps: inventory and preliminary research, pilots in collaboration with ongoing learning communities with eventually scaling up more broadly in SMEs. This brings about a responsive infrastructure for LLO concerning green hydrogen.

### The inventory part involves the following knowledge questions:

- How do rapid (technical) development and upskilling within a tight labor market go together?
- What are given the digital transformation (MOOCs, SPOCs, generative AI, knowledge platforms) plausible future forms for competency development?
- How can educational institutions best respond to the demand of flexible educational offerings?
- What is a supported validation mechanism for testing time-to-job within LLO methods.

This preliminary research is broad and has the application of hydrogen as its starting point, but is expected to be able to permeate adjacent domains within the energy transition without much adaptation. This provides a range of promising innovative training methods that can be tested on a small scale in ongoing learning communities (systems integration or hydrogen) and within

Building block 2 of the LLO catalyst. If successful (demonstrated shorter time-to-job, employee and employer satisfaction), scaling up to other domains, more complex learning communities and big business will be initiated.

## 6.6 Pillar 6: Research & Development

### What:

Research and development traditionally takes place at knowledge institutions in cooperation with regional industry. Many innovation impulses are on a specific sub-topic of (green) hydrogen or more generally green molecules. **Breakthroughs** often take place (inter)nationally, especially at the lower TRLs. As for facilities in the Northern Netherlands, the impact can be increased regionally and nationally if cooperation is strengthened. This can take the form of shared facilities, virtual facilities and multi-level training setups that are also used on a project basis and together with SMEs. This makes it easier for knowledge to find its way into business and for market needs to be met more easily because the knowledge is readily available and up-to-date. Internationally prominent knowledge development and facilities also attract theoretically trained professionals and start ups.

### How:

Research is traditionally done on a project basis in which there is little or no scope for linkage with related regional and national comparable initiatives. This cooperation at program level is crucial to guarantee the impact of joint training and research facilities. Because such matters must also be reflected nationally (GVNL), program formation and some development capacity are desirable.



# 7 Operationalization

Here we elaborate on the regional spearheads in the field of HCA green hydrogen and then in particular the pillars we define in Green PowerNL. Where possible and desirable, we provide a high-resolution outline of anticipated results and activities, *assuming a March 2024 start*.

Pillar	Goals
<b>P1: ongoing regionally coherent approach</b>	Current regional demand articulation
	Knowledge dissemination green hydrogen Strengthened public and private governance on energy transition and circularity and thus also on the hydrogen transition (European Hydrogen Valley)
<b>P2: Valorization national knowledge platform</b>	Current content for knowledge platform
	Continuously maintained knowledge platform
<b>P3: improved positioning of MBO in HCA green hydrogen</b>	Implementation plan improved development capacity MBO
	Pilot within 1 of the affiliated MBOs
	Culture change MBO (inter)regional replicated
<b>P4: scale up learning communities hydrogen</b>	Validation framework LC hydrogen
	Scaling framework LC hydrogen
	Completed Pilot LCs
	10 Developed micro-LCs
	5 Developed macro-LCs
<b>P5: LLO and new ways of working, learning, innovating</b>	Up-to-date curricular offerings
	Review framework for innovative LLO solutions.
	Validated unconventional training methods
	Implemented unconventional training methods scaled up and replicated
<b>P6: research &amp; development</b>	Strategy scaling up hydrogen production and use
	Implementation plan shared (digital) training and experimentation facilities
	Knowledge development program SMEs
	Pilot lab integration

Table 1 overview of goals and results per HCA pillar in the Northern Netherlands

Positioning and leading role we do not consider relevant at this stage. The results can then be translated into activities. The duration and scope of these activities is **emphatically an indication** and depends on current applications, programming at the regional level and complexity in decision-making.

## 7.1 Pillar 1: ongoing regionally coherent approach

Result	Activity	Schedule: start (duration)
Current regional demand articulation	regional liaison team ( 3 years)	March 2024 (3 years)
	Practice-oriented research on SME demand articulation and training needs	August 2024 (1 year)
Knowledge dissemination green hydrogen	Regional Program Formation Green Hydrogen	March 2024 (3 years)
	Events around green hydrogen applications	March 2024 (3 years), 4 times a year

## 7.2 Pillar 2: Valorization national knowledge platform

Result	Activity	Schedule: start (duration)
Current content for knowledge platform	Create communication framework	March 2024 (4 months)
	knowledge development framework	March 2024 (4 months )
	Joint content creation	March 2024 (3 years)
Continuously maintained knowledge platform	Post content	March 2024 (3 years)
	Interaction with users (assistance)	March 2024 (3 years)
	Technical maintenance	March 2024 (3 years)

## 7.3 Pillar 3: improved positioning of MBO in HCA green hydrogen

Result	Activity	Schedule: start (duration)
Implementation plan improved development capacity MBO	Practical research on processes within MBO and HBO	September 2024 (6 months)
	Retrieving needs business community	September 2024 (6 months)
Pilot within 1 of the affiliated MBOs	Expanding ongoing course(s) of study.	April 2025 (1 year)
	Aligning HBOs and business	April 2025 (2 years)
Culture change MBO (inter)regional replicated	Using pilot(s) to launch replication	April 2026 (2 years)

## 7.4 Pillar 4: Scaling up learning communities hydrogen

Result	Activity	Schedule: start (duration)
<b>Validation framework LC hydrogen</b>	Practical research on existing LCs	May 2024 (1 year)
<b>Scaling framework LC hydrogen</b>	Practical research on future LCs	May 2024 (1 year)
<b>Completed Pilot LCs</b>	Feedback for process improvement	March 2025 (3 months)
<b>Developed micro-LCs</b>	Recruit students	May 2024 (3 years)
	Exploratory discussions with stakeholders	
	Drawing up cooperation agreement	
	facilitate learning community in operational phase	
	Working on innovation questions	
<b>Developed macro-LCs</b>	Recruit students	May 2024 (3 years)
	Exploratory discussions with stakeholders	
	Drawing up cooperation agreement	
	facilitate learning community in operational phase	
	Working on innovation questions	
<b>Up-to-date curricular offerings</b>	Ongoing monitoring of knowledge gaps	May 2024 (3 years)
	Adapt existing training offerings (initial)	
	Supplement cursory offerings	
	Develop new, transferable, knowledge	

## 7.5 Pillar 5: LLO and new ways of working, learning, innovating

Result	Activity	Staffing
<b>Review framework for innovative LLO solutions.</b>	Survey training needs business and employees	September 2024 (1 year)
	Desk research labor market	
	Establish validation mechanism	
	Implementation plan for LCs	
<b>Validated unconventional training methods</b>	Drafting pilot training offerings	March 2025( 6 months)
	Intervision with employers and trainees	
<b>Implemented unconventional training methods scaled up and replicated</b>	Establish process description based on experiences within regional LCs and LLO catalyst	November 2025 (6 months)
	Implement LLO offerings on a larger (number of trainees, several pools) scale	November 2025 (2 years)
	Ongoing Intervision	November 2025 (2 years)

## 7.6 Pillar 6: research and development

Result	Activity	Staffing
<b>Strategy scaling up hydrogen production and use</b>	<ul style="list-style-type: none"> <li>Review of ongoing projects on investment agendas.</li> <li>Mapping scale-up challenges</li> <li>Demand articulation within industry, mobility and distribution</li> </ul>	May 2024 (1 year)
<b>Implementation plan shared (digital) training and experimentation facilities</b>	<ul style="list-style-type: none"> <li>Inventory needs SMEs, grid operator(s).</li> <li>Translate project results of current facilities into package of requirements for integration facilities</li> </ul>	May 2024 (1 year)
<b>Knowledge development program SMEs</b>	<ul style="list-style-type: none"> <li>Facilitate development needs of SMEs</li> <li>Fitting work field questions into MBO offerings</li> </ul>	January 2025 (2 years)
<b>Pilot lab integration</b>	<ul style="list-style-type: none"> <li>Set up prototype asset linkage</li> <li>Creating visualization and data mockups</li> <li>define interaction</li> <li>Create and test pilot training modules</li> <li>open dissemination</li> </ul>	January 2025 (2 years)

# 8 Governance of Regional Activities

**We walk the bridge as we build it: how can we structure operations to manage risk and also respond intelligently to new developments such as technical innovations and policy instruments?**

The current set-up of the liaison team in the Northern Netherlands forms the basis, but will be further developed into an advisory part (**sounding board group**), an operational part (**working group**) and a decision-making part (**steering committee**). The advisory part will be expanded with the participation of private parties and governments. The operational part will be strengthened with project support, a program manager, and one or more practical researchers who will focus on the learning questions for the start-up activities of the regional pillars.

In addition to the Liaison Group, a team will be put together to further shape the **dissemination of knowledge** about green hydrogen, which will consist of a program manager to set up a communication and knowledge development framework, a content creator to continuously supplement and expand material for the knowledge platform, and coordination and project support. Since it is convenient for companies/institutions that the demand articulation goes through 1 party, it is obvious that the need retrieval goes through the liaisons and that the follow-up process finds its basis in the knowledge dissemination group.

A number of pillars provide for the development and evaluation of pilots. The collaboration is then set up from the operational liaison team while the implementation lies with the agencies (schools/knowledge institutions/principal LCs).

For **the Learning Communities**, the activities do not start in a vacuum: from LC systems integration, a team of facilitators, project supporters and teacher researchers is at ENTRANCE to develop and facilitate a number of micro- and meso-LCs. This team will be expanded to include teacher researchers for framework development around validation and hydrogen as a domain and capacity to ensure future scale-up of green hydrogen LCs. In addition, practical research on innovative LLO solutions will start within this team. Coordination of LLO pilots and scale-up can then be set up later from the public-private partnership.

Within the ongoing JTF proposals, there are activities to support SME initiatives in green hydrogen. The knowledge development program will closely align with this and participate in the relevant working groups. For the program formation for (digital) training facilities and scaling up hydrogen technology, a collaboration between the knowledge institutions is desired.

A senior researcher will work with involved multi-level stakeholders within HVCE (chairs, professorships, practicals) in a working group to develop a detailed plan to (digitally) integrate parts of labs. Reporting to the steering committee of regional liaisons At a later stage, a pilot will be set up to use a multi-level integrated lab in teaching modules.



Regieorgaan

**Justification:** This track/program was made possible by GroenvermogenNL, a national program of the Ministry of Economic Affairs & Climate, funded by the National Growth Fund and facilitated by Regieorgaan SIA, part of the Netherlands Organization for Scientific Research (NWO)

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